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ABSTRACT

Broad bandwidth transmission systems have been around for years. They include microwave, assorted cable systems, and recently, satellites. With the exception of some privately owned systems, broadband services have been furnished by the common carriers. Recently, a new element has been added--Cable Antenna Television (CATV) distribution systems. The "excess" channels available in CATV systems are seen as an answer for the demand for capacity to transmit large amounts of information. There are some difficulties in utilizing CATV systems as currently configured for two-way communications, but the difficulties seem small when compared to the tremendous benefits which can and should accrue from the interaction of broadband communications and advanced terminal developments. "Interested publics" should watch closely telecommunications developments--particularly regulatory developments--to attempt to escape mistakes of the past, and to ensure close coupling between communications innovations and their beneficial use. (Other papers from this conference are available LI 003360 - 003378 and LI 003380 through LI 003390) (Autho

Conference on Interlibrary Communications and Information Networks

-Network Technology Working Group-

BROAD BANDWIDTH TELECOMMUNICATIONS SYSTEMS

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July 14, 1970

Conference on Interlibrary Communications and Information Networks

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BROAD BANDWIDTH TELECOMMUNICATIONS SYSTEMS

SUMMARY

Broad bandwidth transmission systems have been around for years. They include microwave, assorted cable systems, and recently, satellites. With the exception of some privately owned systems, broadband services have been furnished by the common carriers.

Recently, a new element has been added--CATV distribution systems. The "excess" channels available in CATV systems are seen as an answer for the demand for capacity to transmit large amounts of information.

There are some difficulties in utilizing CATV systems as currently configured for two-way communications, but the difficulties seem small when compared to the tremendous benefits which can and should accrue from the interaction of broadband communications and advanced terminal developments.

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ADDENDA - Summary of Corrections

WORKING GROUP C - Paper 7

Broad Bandwidth Telecommunications Systems

John Sodolski

The following corrections were received too late to be included in the copy reproduced and distributed to Conference participants. Please insert the Summary page and correct your copy as the following notes indicate:

C-7-3

FIGURE 1. BANDWIDTH OF SOME COMMON SERVICES

Required bandwidth 1000 for MHz

...whereby a specific band in the frequency spectrum was assigned..

C-7-4

FIGURE 2. FREQUENCY DIVISION MULTIPLEX

C-7-5

FIGURE 3. TIME DIVISION (DIGITAL) MULTIPLEX

64 Kilobits Transmission Ra ec.

C-7-7

FIGURE 4. (cont.)

----- -----	------ ------	------ ------	Equivalent Data Rate b.p.s.	Explanatory
			4,500	
			500	
			2,000	
			90,000	
			180,000	

C-7-9

Extension upward into the spectrum beyond 12 GHz...

C-7 -10

2. ... This is technically feasible and requires improved (and more extensive) line amplifiers or shorter runs of cable between amplifiers.

C-7-11

4. ... ...back-up sog that even a 60 hertz power "black out" does not interrupt service. CATV DN is powered by the 60 hertz service. Besides power source reliability standards for circuits, components, and lightning protection must also be established.

C-7-12

1. ... ...dedicate certain of its channels to the same end, with video response, however.

2. Reduced Noise and Distortion
   ... ...result in the short cable runs conducive to reduced noise....

Add:

3. Star vs Tree Switching
   BCN's generally would be designed....

C-7-13

Remove:

3. Star vs Tree and Switching.

BROAD BANDWIDTH TELECOMMUNICATIONS SYSTEMS

BROADBAND DEFINITION

In recent years the term "Broadband Communications" has come into popular usage. As used by lay and semi-lay people the term has become curiously inacurate and limited, and "broadband" usually refers to CATV (community or cable television) distribution systems, or other similar cable arrangements. Also, although most of these systems are at present one-way, use of the term "broadband" usually implies a two-way system.

It is important to note that this lay definition of broadband focuses on a developing technology, and other types of broadband transmission systems such as microwave, cable, and recently, satellites, have been and are available.

As to what is a "broad" and what is "narrow," recently it was jokingly observed that if a "narrowband" system (such as the telephone) is compared to a garden hose, then a broadband system is like Niagara Falls. Indeed, so substantial is the increase in capacity of broadband systems that their development may well portend a true revolution in communications.

"Broad bandwidth", as a terminology, has in the past not been uniquely defined, but, has generally been used to mean portions of a transmission frequency spectrum which are at least several, and certainly more than one, conventional four kilohertz (KHz) voice channels in width. The designation of channels was orginally done in terms of the service they were designed to render, for eample, in Figure 1:

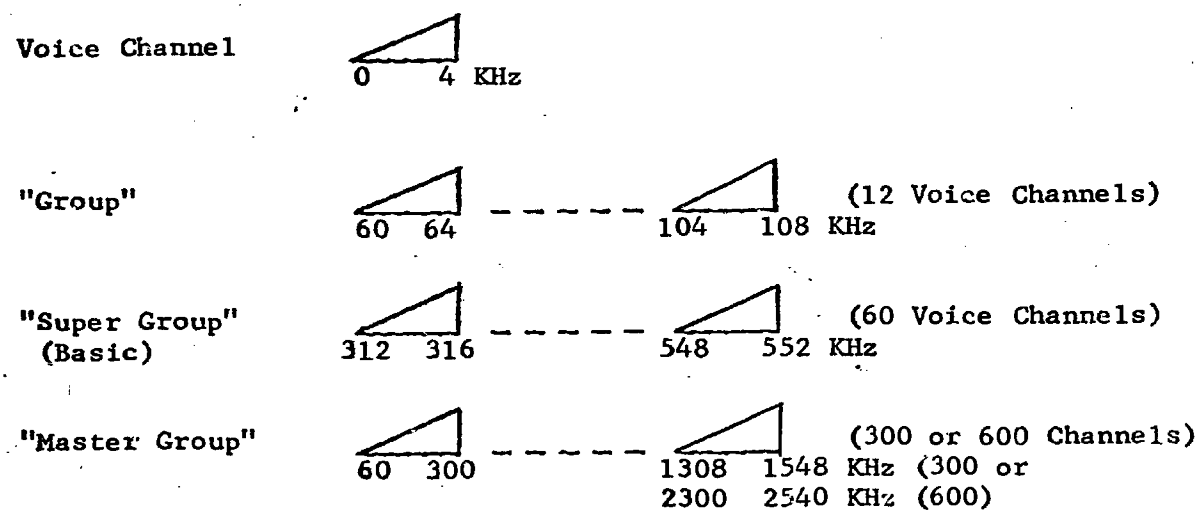
FIGURE 1. BANDWIDTH OF SERVICES

Service	Required Bandwidth x 1000 for MHz
Telegraph (Hand)	0.030 KHz
Teletype	0.170 KHz
Voice (Telephone)	4.0 KHz
Facsimile (6 min.)	4.0 KHz
Facsimile (6 sec.)	240.0 KHz
Television	4,500 KHz (one TV Channel)

AVAILABLE SYSTEMS AND SERVICES

In the process of long distance transmission of these various bandwidth requirements, it became apparent that it was a matter of good economy on high-density, long-haul transmission trunk lines to collect a large quantity of signals and transmit them together over a broad bandwidth facility rather than by individual circuits for each. One plan for doing this was to use "frequency division multiplex" whereby a specific bandwidth in the broadband frequency spectrum was assigned to a specific subscriber's signals. Since this frequency division multiplex scheme was orginally devised for the transmission of telephone channels, the spectrum was divided up into voice channel equivalent 4 KHz segments as shown in Figure 2:

FIGURE 2. ANALOG MULTIPLEX



While it is possible by suitable modulation and demodulation techniques to assemble anywhere from 12 to 1800 voice channels in this manner, for transmission over broadband microwave or cable circuits, it is also possible to enter the multiplex system on a wideband basis. The "Group," "Super Group," and "Master Group" bandwidths shown above, have evolved from telephone practice into the normally available "broad bandwidth" telecommunications channels and are the de facto standards around which broadband terminals are designed for use by the subscribers.

Recently another form of multiplex, designed initially for use on cable, has been introduced into the various telephone systems in the United States. This new multiplex is called "time division" because it shares segments of time between specific subscribers instead of bands of frequency. It also builds up into a hierarchy of multiple channels as shown in Figure 3, and is very important since it is the planned way of the future for the transmission of data and video telephone over existing telephone plant cable

and long haul facilities, and hence may establish new de facto terminal standards.

FIGURE 3. DIGITAL MULTIPLEX

Voice Channel	64 Kilobits
T1	1,544 K_b (24 Channels)
T2	6,312 K_b (96 Channels)
T4	281,000 K_b (Approx. 4000)
T5	562,000 K_b (Approx. 8000)

When the concept of multiplexing a number of voice channels over a broadband transmission facility was first developed, it was purely a matter of optimizing the use of the cable transmission plant investment dollars and the "broad bandwidth" ports into the transmission system were not made available to the ordinary subscriber. After World War II, "broad bandwidth" microwave transmission licenses were made available by the FCC for private communication systems users as well as common carriers. When this happened, it became desirable for the common carriers to make available competing broad bandwidth services in their tariffed offerings. The most widely used of these new tariffs was called "TELPAK" by the Bell System and was simply an offer to let subscribers purchase large blocks of transmission spectrum directly into the multiplex equipment ports at the "Group," "Super Group" and "Master Group" levels. These were called respectively TELPAK A, C and D, and were the first widely used common carrier "broad-bandwidth" subscriber services.

Special broad bandwidth services, in larger sizes than TELPAK D have been made available, especially for the Government and the military, but in

general, the next largest widely used wideband service is 4,500 KHz for the transmission of TV quality video signals primarily for network TV program distribution (although various entrepreneurs have offered point-to-point TV conference services based upon the purchase of video channels from AT&T long lines facilities).

Let us review then the more popular, presently available, broad bandwidth service offerings created from common carrier practices, so that we can proceed toward new and different concepts. Figure 4 shows the name, the designated service, the equivalent voice channels, and the rating for data transmission: (voice included for comparison)

FIGURE 4. SOME POPULAR BROAD BANDWIDTH SERVICE OFFERINGS

Name of Offering	Intended Service	Equivalent 4 KHz Channels	Equivalent Data Rate b.p.s.	Explanatory Notes
Dial Up	Voice	1	1200 to 9600	Useable data rate limited by noise, most systems 1200 or less.
Private	Voice	1	to 9600	Useable data rate depends on conditioning, most systems 2400 or less.
Telpak A (Group)	Voice or Data	12	48,000	(Up to)
Telpak B (2 Groups)	"	24	96,000	"
Telpak C (Super Group)	"	60	240,000	"
Telpak D (Master Group)	"	240	960,000	"

FIGURE 4. (cont'd) SOME POPULAR BROAD BANDWIDTH SERVICE OFFERINGS

Name of Offering	Intended Service	Equivalent 4 KHz Channels	Equivalent Data Rate b.p.s.	Explanatroy Notes
Video	TV	1,125	4,500,000	
T1	Voice or Data	24	500,000	In service, cable Plus developmental microwave T1WB1 = 8 x 64 Kb T1WB2 = 2 x 250 Kb T1WM1 = 1 x 500 Kb
T2	"	96	2,000,000	In test, cable only carries one Picture Phone
T4	Voice or Data	Approx. 4000	90,000,000	In laboratory only.
T5	Voice or Data	Approx. 8000	180,000,000	In laboratory only.

A comparison of Figure 3 with Figure 4, indicates that in the "T" systems shown, the digital transmission rate is about three times the data handling rate while the analog systems (2) vs (4) have data rates which are equal (or greater if multilevel modulation is used), than the bandwidth they occupy.

LIMITATIONS OF PRESENT TRANSMISSION SYSTEMS

The result of this relationship is, that where bandwidth is costly, or the bandwidth is limited by considerations of available spectrum, or interference, it is the general practice to use the more tightly packed analog systems. Microwave, satellites and buried co-axial cable usually follow this practice. On the other hand, where bandwidth is cheap and repeater sites readily available, for example, in a 200 pair telephone cable trunking between

exchanges, the digital T systems offer a simpler, less costly approach.

Now that we have examined the conventional ways in which conventional transmission facilities are carved up into useful pieces of broad bandwidth spectrum, let us examine what constraints mitigate against extensive wideband services expansion of these systems. Figure 5 shows the more useful frequency bands commonly used by microwave systems:

FIGURE 5.

Band GHz	Width, Spacing, MHz	Service	Total Channels (TV)
3.7 - 4.2	500/20	Common Carrier	25
5.9 - 6.4	500/30	"	16
6.5 - 6.8	300/10	PSIT (Public Safety, Industrial & Transportation)	—
7.1 - 8.4	1300/30	Govt.	43
10.7 - 11.7	1000/30	Common Carrier	33
12.2 - 12.7	500/20	PSIT	25
			142

If one examines the ratio of the width to the channel spacing, each of the bands can be host to only a relatively small number of channels as shown in the last column, and, each channel, in general, can carry only one one-way video signal - i.e., for a TV quality videophone transmission, full duplex, two channels would be required. If we took the full microwave spectrum from 2.0 GHz to 12.7 GHz, we would have 10,700 MHz of bandwidth divided by 20 MHz (x 2 for duplex) per subscriber yields only 267 simultaneous video conversations. While this basic figure can be much enlarged upon by consideration of actual

traffic patterns, 1 MHz bandwidth video telephone, and re-use of the same frequencies, it still is obvious that in large metropolitan areas a system would likely be several orders of magnitude below being able either to provide the necessary entrance links or the local transmission for a full videophone service.

Extension upward into the R.F. spectrum beyond 12 GHz offers some hope of temporary relief, but metropolitan multipath propagation problems appear to threaten this escape valve also, and the "broad bandwidth subscriber drop" seems to be gradually but inexorably moved towards that old reliable connection medium, the copper wire, - in this case, a coaxial cable.

Coaxial cable is the usual transmission medium in CATV systems. It is also used very widely in other broad-band communication installments and it is likely that much more will be used in the future.

The cable attenuates the signals, therefore, amplifiers and equalizers have to be spaced out regularly along the cable if the level of the signals is to be maintained. Since each repeater degrades the signals slightly, there is a limit to the number which can be cascaded and a corresponding limit to the length of the spur, depending on the quality of the cable. With existing CATV equipment, the limit is about 15 miles for a system carrying 12 TV channels -- but trends in the technology will certainly extend both the distance and the bandwidth in years ahead,

EVOLUTIONARY DEVELOPMENT OF CABLE SERVICE

The coaxial cable, as a local distribution medium, has the permanent advantage over any form of radio frequency propagation that its inherently broader bandwidth of 300 or more megacycles can be used and re-used, even on the same poles or in the same ducts, as often as the economies of the service dictate,

by simply laying in another cable.

In visualizing a "wired city" concept of the future, there have been a myriad of service concepts generated on the tacit assumption that the "excess capacity of CATV systems" held the key to untold benefits for everyone. If any reasonable person stops to think about it, he can generate largely from his own experience a list of the differences between todays CATV systems and a true transmission system capable of supplying a full service "broad-band-drop" to a high density subscriber area. For example:

1. The broadband communications network (BCN) must be two-way. The CATV distribution network (CATV DN) currently is one-way. It is technically feasible to make it two-way by directional filters at increased cost and sacrifice of some part of the one-way band-width, or simply by putting in two cables and repeater amplifiers.
2. The BCN will require better noise and distortion characteristics than the present CATV DN if interconnection to distant points through high quality transmission trunks (like, e.g., TD-3 microwave, L-4 cable, or domestic satellite) is to be satisfactory. This is technically feasible and requires only a more linear (and more expensive) line amplifier or shorter runs of cable between amplifiers.
3. For switching purposes, many feel the BCN will have to be configured like a star rather than a tree (as is the CATV DN) because even with 300 megacycles of bandwidth, true interconnection with a large number of subscribers in a high density area will require a hierarchy of switching at nodal points just like the telephone exchanges because there simply are not enough (20?) video channels to serve all, even in the relatively pregnant 300 megacycle cable system.

A switched service (or system) is one in which messages originated by a sender are sent only to designated addresses. A switched service may be circuit switched where a direct transmission path is established between sender and receiver or message switched where messages are relayed to the receiver by switching centers in a store and forward manner. Multiple address is available with most switched services. However, multiple-address is considerably more common with message switched services than with circuit switched services.

In non-switched services, the communications channel remains unchanged and all messages are sent to all receiving stations, as in a CATV DN. However, messages can contain addresses so that the receivers can select (i.e., display and/or print out, etc.) desired messages.

4. It is generally assumed by communications engineers that the BCN must be designed to a much higher reliability than the CATV DN. Many BCN services once offered can well be expected to become just as vital to the population as telephone service. Telephone service is highly reliable, battery powered, with gasoline generator emergency charger back-up so that even a 60 cycle power "black out" does not interrupt service. CATV DN is powered by the 60 cycle service. Besides power source reliability, circuits, components, and lightning protection standards must also be established.

There are many other things currently which keep the CATV DN from being the transmission quality network which is required ultimately to fulfill the needs of the BCN.

Should we then at this point concede defeat and start all over again?

[illegible]. CATV DN can be said to have somewhat the same relationship to the

BCN that the telephone networks of the 1900's had to the telephone systems of today. CATV DN can grow into a satisfactory BCN through evolutionary processes similar to the genesis of the telephone system. An immediate task is to guide the evolutionary process by planned experiments designed to hasten the optimization processes which will lead to BCN. In the meantime, care must be exercised not or create restrictive, inhibiting legislation in eagerness to hasten matters.

Let us then examine some compromises and adjustments which may allow for the time being to evade the consequences of the four "sticking points," CATV DN versus BCN, which were previously enumerated.

1. Two-Way Requirement

   For initial experiments, the outbound subscriber traffic will be limited to voice or keyboard entry/request capable of being sent over his existing telephone line. The CATV DN could dedicate certain of its channels to the same end and video response, however.

2. Better Noise and Distortion

   CATV DN has a unique characteristic that its network can be broken up into small "communities of common interest" and it be desirable to do so, especially in the light of local origination requirements. Harlem will want different programs from Park Avenue. Ethnic/sociological area pattern needs are likely to at least result in the short cable runs conducive to better noise and distortion properties in the network.

   BCN's generally would be designed for distribution of information from one source to many receiving locations. The network is like a "tree" with a main trunk and many branches. Separate

"trees" could economically serve separate communities of as few as 1,000 homes. Separate "trees" could build neighborhood communities within massive urban centers. The several trees could be coupled to some common distribution channels and also could choose to tap into separate specialty program sources or interactive meetings, or games such as each community might desire. By starting with basically small "trees," we can obtain the most flexiability in providing services that are of utility to a few local communities of interest, or to the whole nation.

Also for purposes of establishing demand, any experimental service can be kept local in character initially to avoid the need for the degree of quality to sustain long distance interconnection.

3. Star vs Tree and Switching

Some feel the "community of interest" network and local origination will cause the system to be rather more nodal than dendritic. Switching, if required, can for purposes of an experiment be kept very simple, if automatic, or even be limited to manual patching. However, even if the system were dendritic, by using presently available digital technology, flexibility in addressing can be provided so that each receiver can be given an individual (discrete) address. The sender can then select the desired receiver(s) by sending proper address information with mesages. Multiple-addressing can be accomplished by sending each discrete address of each receiver or by establishing and sending a code that designates a class of subscribers.

4. Higher Reliability

Just let the CATV DN be used in the experiment, and as these experiments grow more sophisticated and frequent, the reliability requirement will unsummoned, nevertheless, make its presence known.

The above four points indicate it is possible to utilize developing CATV transmission technology to supplement and augment existing systems. At least it is a beginning.

EXPERIMENTATION ON CABLE

An approach, utilizing broadband communications, to library services was described in a recent filing to the Federal Communications Commission.[1] The service described was called the electronic home library service (designated BCNL). With such a service available a reader could request a book or periodical from a central library, using a narrowband channel to the library (a phone circuit or the BCN itself). The desired book is then "transmitted" from microfiche, microfilm, or video tape, page by page, and received via the BCN network on a dedicated wideband channel.

Several modes of operation are possible. In one, the entire book or selected article is transmitted at the maximum reception speed of the user's facsimile recorder. Several hundred simultaneous transmissions in time-division multiplex are possible with 6-MHz BCN channels and reasonable recorder speed.

As an alternative, a soft-copy display can be used. Each page is transmitted and stored at the receiver for reading. When the reader has

1/ The Future of Broadband Communications, The Industrial Electronics Division, Electronic Industries Association (IED/EIA) response to FCC Docket 18397, Part V, dated Oct. 29, 1969.

finished one page, he signals for the next page, and this is transmitted in a small fraction of a second with no perceptible delay. This is another form of time sharing of the broad-band channel.

To get a feeling for the capacity of a broad-band channel, it is of interest to note that in one demonstration the entire text of "Gone With the Wind" was transmitted in facsimile over a television microwave circuit in slightly over two minutes. 2/

In its early stages a library service would undoubtely be limited in quality of the recorded images. The goals of graphic arts quality, color reproduction, and other refinements will gradually be attained as technology advances and as public demand develops. BCN offers a favorable transmission medium in band width and propagation characteristics for such growth in image quality.

In addition to public access to libraries, the BCN could operate at the "wholesale" level, between and among libraries. Rare volumes at remote locations would be readily available. Earliest applications might be expected in rather specialized uses, such as medical or law libraries. For any of these services, the terminal equipments and bandwidth requirements would be about the same.

A word about terminals. When thinking about terminals, one should remember just what are the human senses and sensory responses. Existing and yet-to-be-developed terminals are simply extensions of those human capacities, extended to a distance utilizing broadband transmission techniques. It is

2/ The Library of Congress encouraged this demonstration of a means of making its vast collection available to every U.S. citizen. The public showing was given at the Library in October 1948.

perfectly obvious that these extended senses will greatly expand and enhance the capability of an operator to perform difficult and complex tasks.

As broadband techniques evolve, and as local systems are interconnected with one another, the user/subscriber could have available to him at his console a telephone, a high-speed printer, a video screen, and a facsimile machine. The interaction of these terminals with computers, other terminals, and among themselves offers a flexiability and nuance of such breathtaking proportions that it is now only dimly recognized by even those closest to these developments.

INDUSTRY ORGANIZATION

When most people think of the telecommunications industry, they think of the phone company. While this assumption generally is a valid one, there is in fact a number of phone companies, many of them independent. Some substantial areas of the U.S. are within the purview of non-AT&T companies. Also, there are other common carriers some well known such as Western Union, and others, like Arinc, known only within the airline industry it services.

Most broadband services and facilities are procured from common carriers. Many users who have large bandwidth requirements lease "dedicated" facilities from a carrier.

Since World War II, there has been a substantial growth in private microwave systems. This has been particularly true in the case of right-of-way companies such as railroads, or gas transmission pipelines where ownership of right-of-way makes installation of microwave equipments considerably more economic than it otherwise would have been.

Lately, there has been a new development likely to affect the provision

of broadband services. The Federal Communications Commission has received a number of applications from so-called special common carriers. These special carriers propose to provide unique services which differ from the traditional offerings of existing carriers. In some cases the offerings are digital for use with data, in other cases the offerings are simply broad bandwidth in nature, and in still other cases the customer is offered an option of various services between two cities such as Chicago and St. Louis. All the returns are not yet in in the special "common -carrier" question. One such system has been authorized by the FCC but many more are pending.

With regard to the growing CATV distribution system--and the BCN--it is likely that a number of locally-franchised companies will wire cities. If the FCC sets proper standards early enough, then these all can be interconneted. This interconnection can be accomplished via an existing common carrier, via satellite, or via "special" common carriers. If such interconnection is accomplished, and should the network evolve with significant switching capabilities, the final network could look very much like the current telephone system.

No discussion of broadband communications or any other type--would be complete without mentioning the regulatory environment. Indeed, there are those who maintain the only limitation on the productive use of burgeoning communications technology is regulatory in nature. Be that as it may, to quote from the previously-mentioned IED/EIA response to the FCC:

> "The broadband communication facility would tend to have public monopoly characteristics and thereby should be regulated, but only to the extent necessary (1) to insure equitable access to all desiring to offer a communication service, and (2) to protect the right of attachment of associated terminal equipment, and (3) to insure competitive purchase of necessary hardware. These communication services

> and associated terminals should not be regulated anymore than other information media are regulated--such as newspapers, magazines, books, movies, etc. This situation is similar to the Carterfone case where the clear distinction was drawn between the terminal equipment and the common carrier facility. This decision has and will continue to encourage the application of new technological resources from potential new suppliers to help solve the numerous communications problems."

And:

> "The public interest can best be served currently, in the immediate future, and the long run by preservation of free, open, and effective competition for the communication services that are and will become economically feasible where broadband cable systems are installed. To insure this development, there should be a clear distinction between the communication service (CATV, video telephone, mail, and data communications, etc.) being offered the public and the transmission medium (broad-band cable system) which carries the communication service."

These paragraphs represent a consensus among many knowledgeable observers in the electronics and communications industries. It would be well for every interested party to recognize early the implications of the decisions regulatory agencies must make, and to watch closely the regulatory as well as the technical development of broadband systems. Hopefully, with a high degree of vigilance and understanding, we may be able to avoid some of the mistakes of the past.

There are a myriad of services which may be provided by utilizing broadband communications. The list of potential services is endless, and in many cases, the viability of the service is dependent on sharing facilities with other users and services. Proper, early planning and experimentation to determine which services lend themselves particularly to broadband techniques and to identify opportunities--and perhaps problems--involved with the sharing of facilities should be encouraged.

How, and by whom, the interconnection of local distribution systems

is done can have a tremendous effect of the system's flexibility and its ultimate utility to the user. Not only are there competing technologies for the interconnection task, but also competing entities. Some hard choices will have to be made. You should be involved in those choices.

As with the potential and promise of broadband transmission systems, the difficulty of the problems involved and the hard decisions to be reached are only beginning to be recognized outside the communications fraternity. The Federal Communications Commission in particular must address in the near future a number of knotty problems, most of which are considerably beyond the purview of this paper, but which nonetheless will affect in a major way the composition and structure of the BCN. Interlarded with the FCC's interest are the ambiguous and often contradictory regulatory policies of some state and local governments. For example, unwise local franchising policies may stifle or misdirect CATV and BCN growth, and prolong the period we must wait for the promised benefits of broadband systems. As a matter of fact, franchising agreements have already become a political question in at least one major city.

Probably more than at anytime in the past it is essential that "interested publics" keep a watchful eye on telecommunications policy to ensure that broadband systems develop in a competive, innovative, and orderly manner. Of prime importance--experimentation should be encouraged in order to exploit maximum benefit from broadband communication technology.

SUMMARY

Broad bandwidth transmission systems have been around for years. They include microwave, assorted cable systems, and recently, satellites. With the exception of some privately owned systems, broadband services

have been furnished by the common carriers.

Recently, a new element has been added--CATV distribution systems. The "excess" channels available in CATV systems are seen as an answer for the demand for capacity to transmit large amounts of information.

There are some difficulties in utilizing CATV systems as currently configured for two-way communications, but the difficulties seem small when compared to the tremendous benefits which can and should accrue from the interaction of broadband communications and advanced terminal developments.

"Interested publics" should watch closely telecommunications developments--particularly regulatory developments--tc attempt to escape mistakes of the past, and to ensure close coupling between communications innovations and their beneficial use.

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